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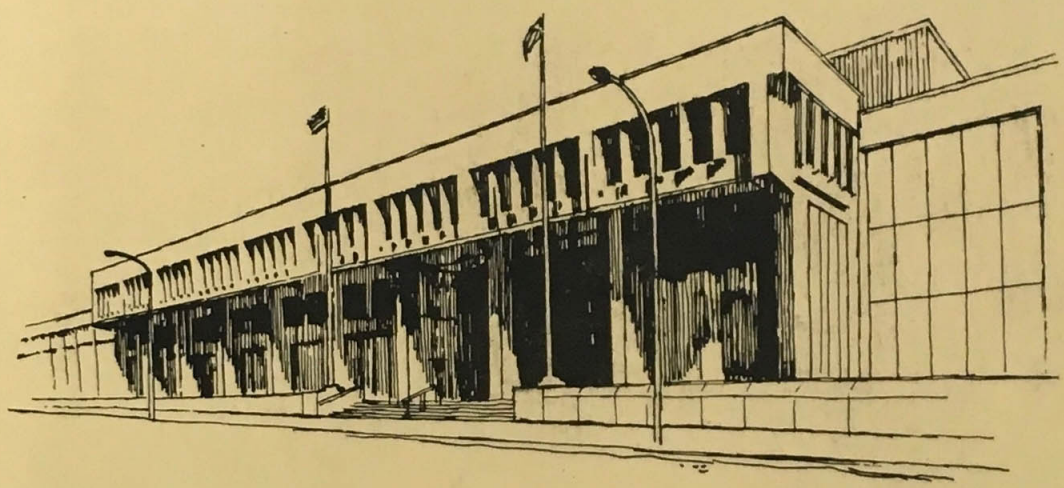
Handbook on Coin Manufacturing Processes at the Mint

UNITED STATES TREASURY DEPARTMENT

Bureau of the Mint



August 1969

FOREWORD

Presented herein is general information on the various coin manufacturing processes used at the new United States Mint in Philadelphia. A brief narrative on each operation and space for your notes are provided.

If you would like clarification on a particular item or subject, please feel free to ask any of the U. S. Mint personnel in attendance.

We hope this information will be of value and we thank you for giving us the opportunity to present it to you.

Eva Adams
Director of the Mint
August 13, 1969

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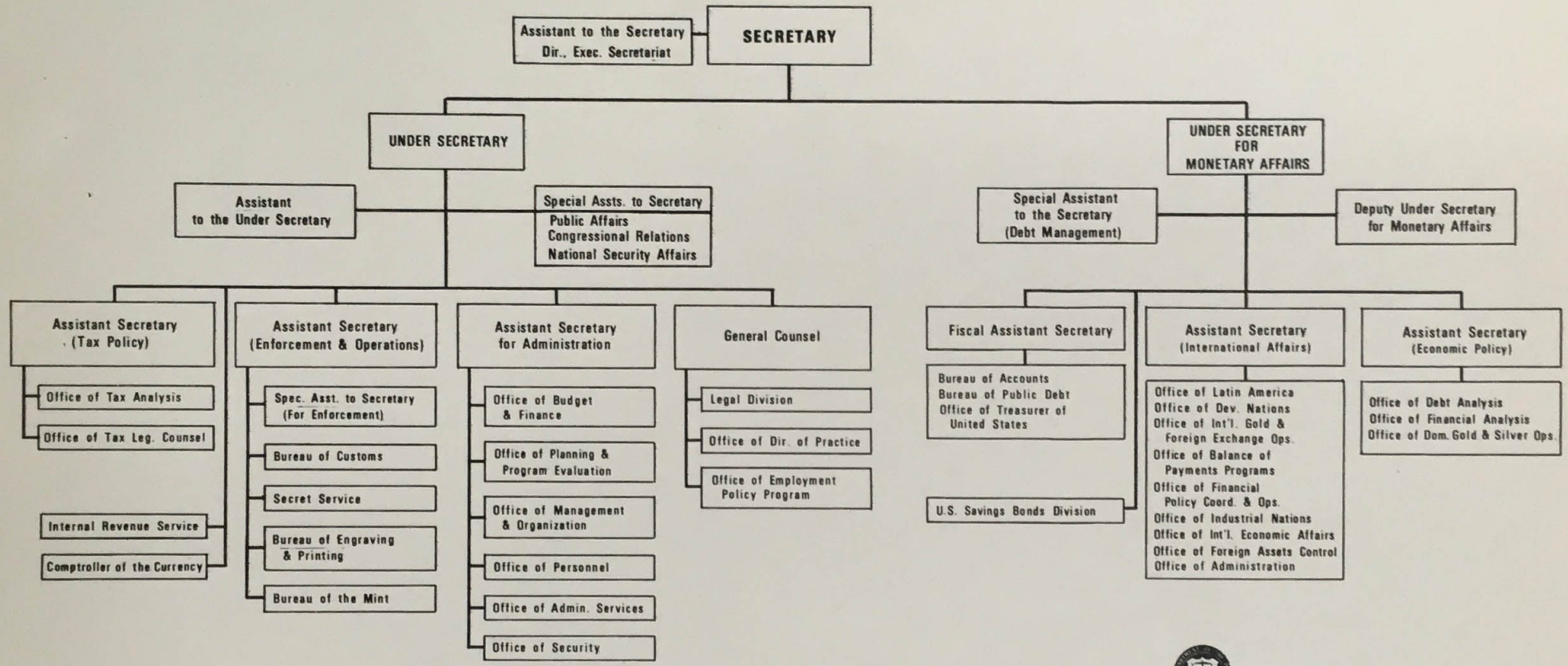
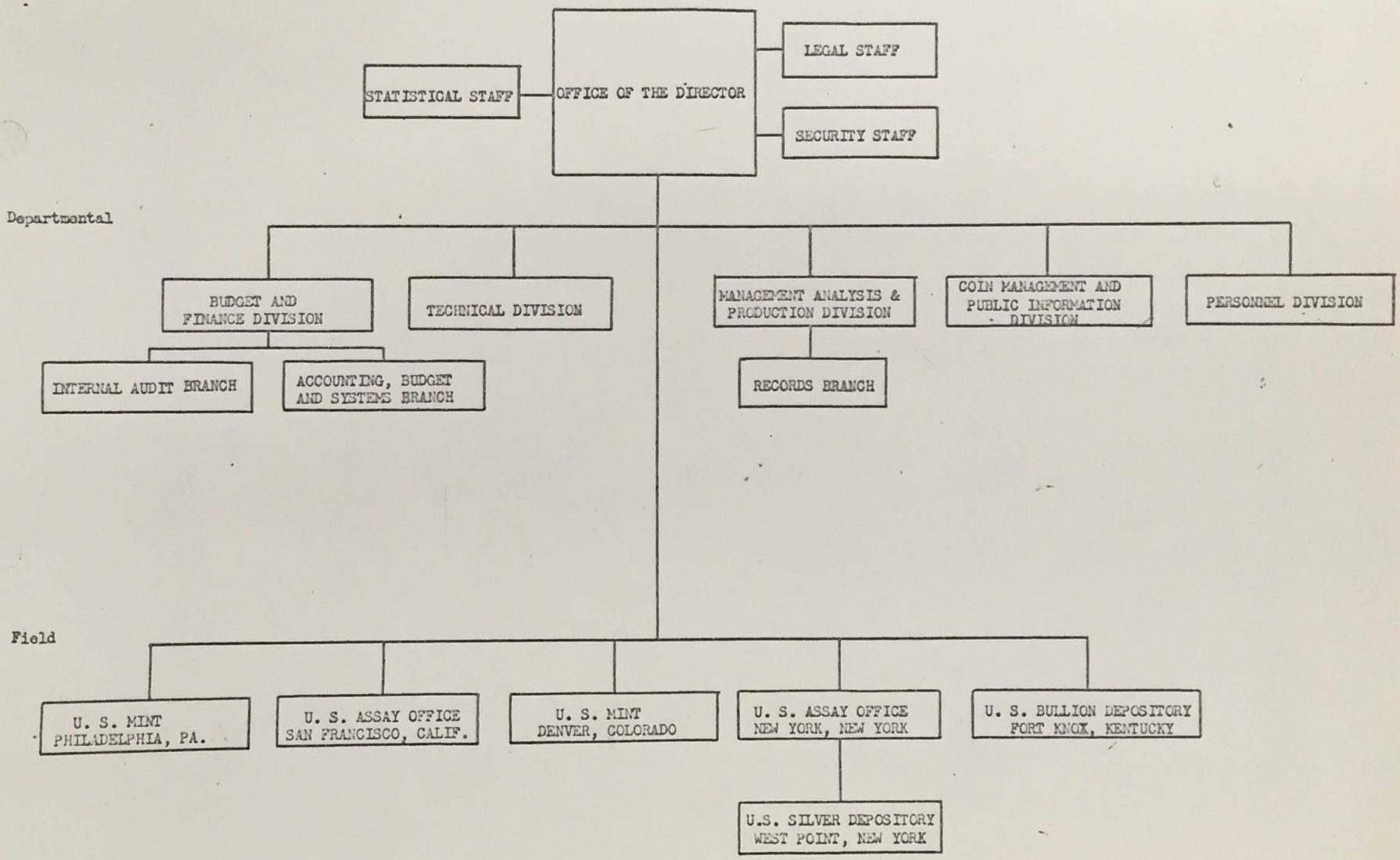
ORGANIZATION OF THE DEPARTMENT OF THE TREASURY



Date: *April 1, 1969*

BUREAU OF THE MINT
TREASURY DEPARTMENT

MARCH 31, 1969
WASHINGTON



AGENCY MISSIONS AND STATUTORY AUTHORITIES

Agency Missions

The major activities of the Bureau of the Mint are the production of coin, both domestic and foreign; the manufacture of medals of a national character; the manufacture and sale of proof coins and uncirculated sets; the custody, processing, refining, and movement of bullion; the disbursing of gold and silver for authorized monetary, industrial, professional, and artistic purposes; the distribution of newly minted coins for general circulation through the facilities of the Federal Reserve Banks and Branches; the return of uncurrent coins, through the facilities of the Federal Reserve Banks and Branches, after they have been withdrawn by the commercial banks of the country when too worn to continue in active circulation; the analysis and compilation of general data of worldwide scope relative to gold, silver, and coins; and such other functions relating to accounting, budgeting, and personnel as necessarily pertain to an administrative office.

The chief officer of the Bureau of the Mint is the Director of the Mint, who is under the general direction of the Secretary of the Treasury. The Director is appointed by the President, by and with the advice and consent of the Senate, and holds office for the term of five years.

The Bureau of the Mint consists of the Office of the Director in Washington, and six field institutions. The six field institutions are two mints--one at Philadelphia, Pennsylvania, and one at Denver, Colorado; two assay offices--one in San Francisco, California, and one in New York, New York; and two bullion depositories, one at West Point, New York, which operates as an adjunct to the New York Assay Office, and the other located at Fort Knox, Kentucky. Three plants manufacture coins--the Philadelphia Mint, the Denver Mint, and the San Francisco Assay Office. A new 37 million dollar mint in Philadelphia is near completion.

Statutory Authorities

The principal laws concerning the functions and operations of the Bureau of the Mint are:

Title 5, U.S. Code -- Government Organization and Employees
Title 18, U.S. Code -- Chapter 17, Coins and Currency
Chapter 25, Counterfeiting and Forgery
Chapter 31, Embezzlement and Theft
Title 31, U.S. Code -- Chapter 7, Bureau of the Mint, Mints and Assay Offices
Chapter 8, Coins, Coinage and Currency
Chapter 9, Legal Tender
Title 41, U.S. Code -- Public Contracts

The following is a list of some specific Mint functions and the related statute of authority:

Statutory Authorities (continued)

Manufacture of Coin (31 U.S.C. 251,275)
- Design and Manufacture of Dies (31 U.S.C. 276,324)
- Purchase of Coinage Metals (31 U.S.C. 335,340,393)
- Production of Coin (31 U.S.C. 275,391)
- Pyx Coin for Assay Commission (31 U.S.C. 352,363)
- Delivery of Coin to the Federal Reserve Banks (Treas. Order No.179)

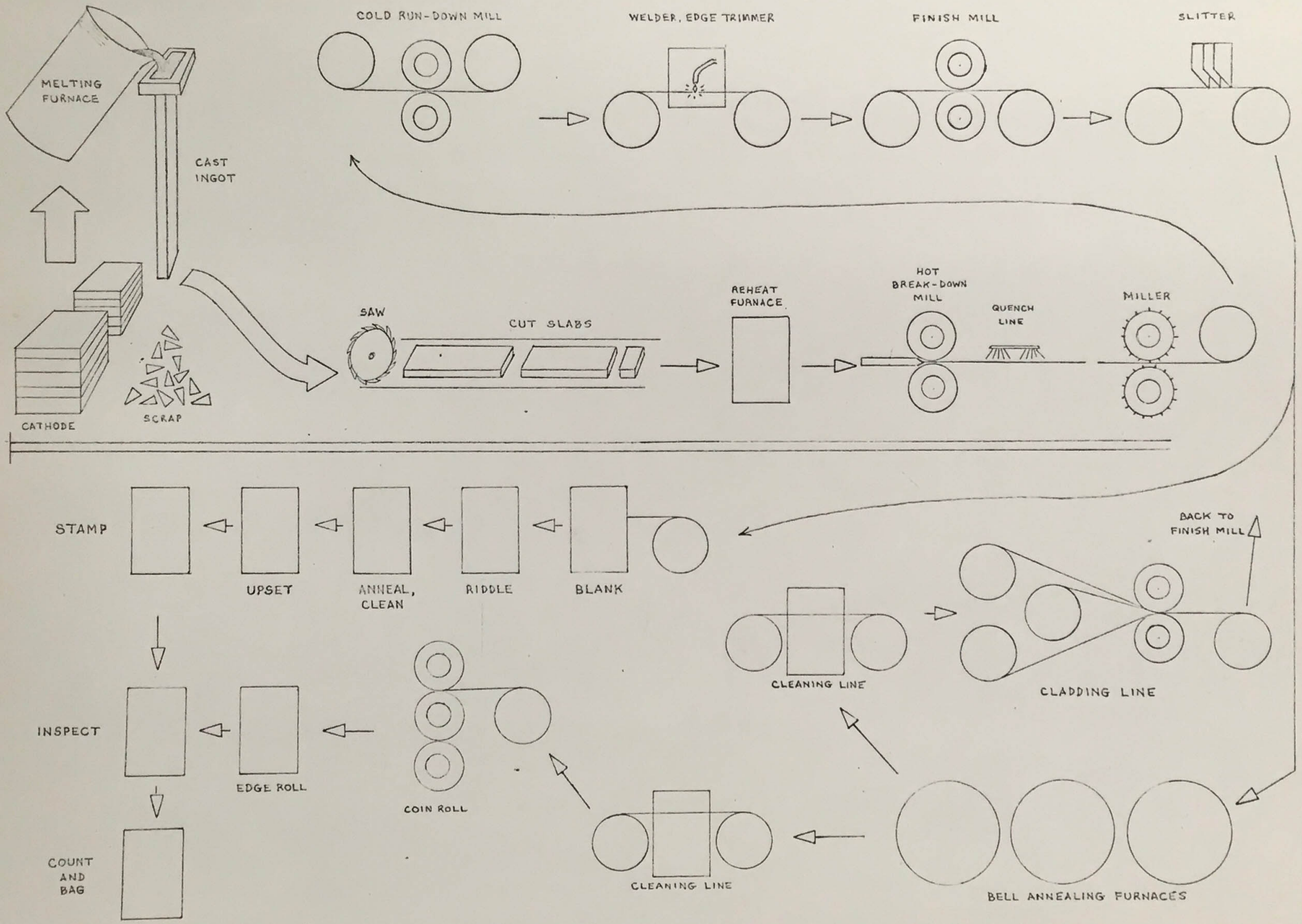
Gold and Silver Transactions (Supplemented by Title 31, C.F.R.)
- Receipt of Deposits (31 U.S.C. 273,325,327,328)
- Assaying (31 U.S.C. 277,330)
- Melting and Refining (31 U.S.C. 274,347,361)
- Exchanging Bullion and Charges (31 U.S.C. 332,357,360)
- Storage (31 U.S.C. 370)
- Safeguarding (31 U.S.C. 273)
- Buying Newly-Mined Silver (31 U.S.C. 394)

Manufacture of Foreign Coin (31 U.S.C. 367)

Manufacture of National Medals (31 U.S.C. 368)

Money arising from charges and deductions covered into Treasury (31 U.S.C.369)
- Manufacture of Special Coin Sets

Annual Settlement of Accounts (31 U.S.C. 354,355)



U.S. MINT, PHILADELPHIA ~ COIN PRODUCTION, FLOW DIAGRAM

U. S. MINT CLAD METAL COINAGE

In 1964, the U. S. Treasury assigned the Battelle Memorial Institute to the project of investigating metallic and non-metallic materials which could be used as a substitute for the 90% silver, 10% copper alloy used in the coinage of dimes and quarters since the late 1700's.

Five main criteria were used in Battelle's study.

Availability and price.
Acceptability to the public.
Effect on coin-operated devices.
Effect on Mint operations
Counterfeiting, illegal duplication
and slugging potential.

The materials considered were ceramics, plastics, aluminum, chromium, columbium, copper, manganese, molybdenum, nickel, titanium, tungsten, zinc, and zirconium.

One of the most important criteria was that this material had to be acceptable in the present day rejection system used in coin-operated vending machines, telephones, etc. No solid material investigated met this requirement except copper alloys which were reddish in color, and therefore, unacceptable to the public eye. However, the major "materials review" initiated by the Mint resulted in a composite of cupro-nickel (75% copper - 25% nickel) clad on either side of solid copper as being the only material that fully satisfied all of the requirements for the coinage material.

Notes

Clad metals as metallurgical products are not new as evidenced by their history in the thermostatic bi-metal industry where an engineering advantage is gained that is not available with any single metal--that is to flex under differential temperatures. Clad metals are not new in the precious metals industry either where they have been used for years to conserve the precious metal by having a base of a less expensive material. However, the materials concept of cladding metals to achieve engineering and economic advantages has "come to life" in the United States due to the success of the cupro-nickel clad copper substiture for the 90% silver - 10% copper alloy used for the coinage of dimes and quarters.

The process by which this new clad metal coinage is made involves three basic steps:

1. Start with three coils of metal

   .048" thick cupro-nickel (16.7% of the total input thickness)

   .200" thick copper (66.7% of the total input thickness)

   .048" thick cupro-nickel (16.7% of the total input thickness)

   The ratio of thicknesses of the three input materials will remain the same through the balance of the processing.

2. All three coils are then cleaned thoroughly and the surface is brushed to remove all oxides.

3. The metallurgical bond is achieved by bringing the mating surfaces together and imparting a force by rolling that causes a sharing of electrons at the interface. The bond achieved by this method is at the atomic level and considered to be a true metallurgical bond.

Notes

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BONDING METHODS

The Coinage Act of 1965 provided that the quarter dollar and dime should be produced from a clad material composed of cupronickel outer layers metallurgically bonded to an inner layer of pure copper. Due to the requirement of an early replacement of the coin silver pieces of these denominations, then in circulation, it was necessary that great quantities of clad strip be obtained by the Mints from the cladding industry whose available production facilities were extremely limited. It was necessary to enter into contracts for strip with those companies whose capacities could be quickly expanded in order for the Mint to obtain adequate supplies of clad strip.

The following are descriptions of the basic principles of the various methods of bonding, no two of which were found to be identical. Many of the details of the methods are, of course, covered by patents.

Metals and Controls, Inc., Division of Texas Instruments, Inc., Cold Bonding of Strips

Strips of the proper gauges for bonding is thoroughly cleaned and dried. The strip is fed to the bonding mill through wire brush stands which prepare the surfaces to be bonded. The bonded strip is taken up on a reel on the output side of the bonding mill. Coils of bonded strip are sintered to strengthen the bond and are then cleaned and rolled to finished gauge.

E. I. du Pont de Nemours & Co., Explosive Bonding of Plates

Du Pont uses an explosive cladding method wherein slabs of plates of appreciable thickness are bonded together. Total thickness of the bonded cake is several inches prior to rolling. The faces of the plates to be bonded are cleaned and brushed. The cupronickel plate is placed upon the thicker copper core plate and the combination is mounted in a supporting framework. The explosive is applied to the cupronickel plate. The detonation of the explosive bonds the two slabs. The second cupronickel slab is joined to the core in a similar operation. The thick composite ingot is now ready for rolling to finished gauge.

Composite Metal Products, Inc., Hot-Roll Bonding of Plates

The plates are thoroughly cleaned and wire brushed in preparation for bonding. The two outer cupronickel plates are clamped to the copper core. A cupronickel frame is welded completely around the edges of the resulting three-layer stack of plates. The welding completely seals the stack except for a small pipe fitting which is welded into one end of the stack. The interior of the stack is evacuated through this pipe fitting. Any remaining air is purged with an inert gas and the pipe fitting is closed giving a heremetically sealed package. Bonding is accomplished by hot rolling the large six inch thick composite slabs in a hot rolling line normally used for steel rolling. During succeeding rolling operations, the cupronickel frame is sheared and trimmed from the ends and sides of the strip so that only the three-layer composite strip remains.

FOR RELEASE AFTERNOON NEWSPAPERS
THURSDAY, AUGUST 14, 1969

COIN ROLLING MACHINE

The Manufacturing Development section of General Motors Corporation, at Warren, Michigan, under contract to the Treasury Department, Bureau of the Mint, has developed a coin rolling machine. The purpose of this machine is to drastically increase the production of coins with equal or better quality than conventional coin presses.

The new coin machine consists of two stands, using rolls to continuously punch and emboss coins from a coil of metal. Peripheral equipment includes a straightener and scrap chopper.

Two ton coils of metal for cents--95 percent copper and 5 percent zinc--are fed at 100 feet per minute through the equipment. The coil is five inches wide and 48 one-thousandths of an inch thick. It will yield 350,000 pennies.

The metal strip leaves the coil, passes through a straightener, and enters the first stand where about 50 percent of the metal is converted into cents. The half used strip then enters the second stand where nearly all the remaining metal is turned into coins. The unused portion of the strip of skeleton emerging from the from the second stand is shredded and reclaimed.

Each stand contains tooling in six rows, producing cents six abreast from the five inch coil. The first stand contains 102 separate tools, and the second, 93. Both stands include three rolls and operate in the same manner.

As the metal strip enters the stand, it passes between the first two rolls. Blanking punches on the first roll punch the blanks. The blanking dies or cavities in the second roll also contain coining punches that will stamp the obverse or head side of the coin. As the rolls rotate, the blanks are carried downward to meet the third roll, thus providing automatic transfer.

In the third roll are the reverse side coining punches. When the second and third rolls rotate so that the obverse and reverse punches are in direct vertical alignment, both sides of the coin are embossed with a force of 45 tons.

Since a simple rolling action would elongate the coin in the direction of rolling, the reverse punch tooling is designed so that the punch faces remain parallel during the embossing interval. The resulting coins are round.

Each embossed coin remains in the second roll until an eccentric cam activates the obverse punch behind the coin to eject it from the collar.

Ejected coins fall into six chutes--one for each circumferential row of tooling. The chutes direct the coins to a belt, which delivers them to bins where they are stored until released by an inspector. A system of levers and bins allows the inspector to segregate good and bad coins into wheeled trucks which will hold the entire output of the 4,000 pound coil. This system also segregates coins according to the tooling used in their production, so that faulty tooling can be traced rapidly.

When an inspector rejects coins produced from a specific row of tooling, the offending tools can be replaced during the short period when the machine is threaded with a new coil of metal. Obverse punches are changed quickly by replacing a one-third section of the roll containing the die. Reverse punches are changed individually.

Following inspection, the coins are processed through an edge rolling machine. In this machine the coins move along a track where wire brushes remove any burrs that Might have been formed. The track leads the coins into a groove of diminishing size between a spinning wheel and a stationary block. Here the coins are revolved and squeezed, which raises and polishes their edges.

The new coin rolling machine is compact--requiring floor space only 25 by 75 feet, with an overhead clearance of 10 feet. These dimensions include aisle and trucking space.

The coin rolling machine will produce approximately 10,000 cents per minute. This compares to abour 600 per minute produced by the present conventional four-strike press.

Notes

Notes

RECEIPT AND STORAGE OF RAW MATERIALS

Trucks containing up to twenty tons of raw material each in the form of copper or nickel cathodes, zinc slabs, or cut nickel in drums, may be unloaded at one of seven truck bays. Approximately one-half acre of secured bulk-storage area is available for storage of these raw materials.

Notes

MAKE-UP

The copper or nickel cathodes and zinc slabs are cut by shears into small pieces and each is conveyed by belt to one of seven storage bins. As required for the melting operation, material is drawn from these storage bins in the proper ratio of the alloy desired, weighed, and carried by overhead crane to the vibratory furnace feeder.

Notes

MELTING

The Mint has four electric induction melting furnaces for melting coinage metals. Each furnace has a capacity of approximately 15,000 pounds per melt and requires about 45 minutes of loading and melting time. Each furnace is fed automatically by a vibratory feeder which is mounted on tracks to facilitate its movement to and from the furnace. An operator controls the feeding of the furnaces and monitors the furnaces to be sure they are operating properly.

Notes

CASTING

The casting of the molten metal is done semi-continuously on three separate casting machines. Each machine may be set up to cast either single or double strand.

The casting machine consists essentially of an open end water-cooled mold, with a water-spray system below the mold to rapidly cool the emerging ingot. The molten metal is poured into the top of the mold, is solidified and pulled through the bottom of the mold.

Each ingot that is cast weighs approximately 6,500 pounds and is 6 inches thick, 16 inches wide and 18 feet long.

The cast ingot is transported by conveyor to a circular saw where the shrunken end is removed and the ingot is cut into two slabs 6 inches thick, sixteen inches wide and approximately 103 inches long.

The slabs may be placed in storage or are reheated prior to hot rolling.

Notes

SLAB REHEATING

The slabs cut from the cast ingot are conveyed to the sixty cycle electric induction reheat furnaces and heated to a uniform temperature. After reaching the desired temperature, which takes about 15 to 20 minutes, the slabs are ejected and conveyed to the hot breakdown mill.

Notes

HOT BREAKDOWN MILL

The reversing hot breakdown mill will reduce the 6 by 16 inch slab $8\frac{1}{2}$ feet long, to a strip which is .450 inches thick by 16 inches wide by 114 feet long. This reduction is made in from seven to eleven passes through the mill. Upon leaving the mill on its final pass the strip passes through a quench tank where water is sprayed on the strip reducing its temperature.

Notes

MILLING

Before further reduction, surface defects are removed from the strip by milling. The milling machine removes a thin layer, .025 of an inch thick, from both the top and bottom surfaces of the strip to improve the surface quality. The thickness of the strip after milling is .4 inches. The strip is rolled into a coil after the milling operation.

Notes

COLD RUNDOWN MILL

To further reduce the thickness of the strip, the milled coils are conveyed by an overhead crane to the rundown mill. The rundown mill is a four-high mill having 13" diameter work rolls and 27" diameter backup rolls, both of which have a roll face of 22". This mill is a one-way mill and will produce strip which is from 0.115 to 0.187 inches thick and from 246 to 397 feet long, depending on the alloy. The coils after this operation weigh approximately 2800 pounds.

Notes

WELDING AND EDGE TRIMMING

After the strip has been through the cold rundown mill, it is processed through the welder and edge trimmer. The welder butt welds two or more coils together to form a larger coil for subsequent operations, while the edge trimmer removes any rough edges of the strip to improve the control of the strip in following operations.

Notes

FINISH MILL

The "C" Mill is a four-high reversing finish mill having 8-1/2" diameter work rolls and 24" diameter backup rolls, both of which have a 22" roll face. It is designed to cold reduce 15-1/2" maximum width material starting at 0.115" thickness to finish thickness of 0.039" to .064. When the strip is at final gauge, it is coiled and conveyed to the slitter and trimmer. The coil weight at this point may vary from 4,000 pounds to 13,000 pounds.

Notes

SLITTING AND TRIMMING

The final gauge strip which is fifteen inches wide will be slit into two or three narrower strips, depending on the material, and the later production processes. The edges of the strip are trimmed at the same time as it is being slit. The strips after slitting are recoiled.

Notes

BELL ANNEALING

The bell annealing facilities consist of 6 stands and 2 heating hoods that are placed over the stands for annealing. Each stand can hold approximately 41,000 pounds and it requires 8 hours of heating and 16 hours of cooling time for each charge.

These furnaces will be used for annealing all of the coiled strip for the Coin Roller and for the cladding line. The capacity of the facility is 10,000 pounds of annealed strip per hour.

Notes

STRIP CLEANING LINE

There are two strip cleaning lines. The material for these lines comes directly from the Bell Annealing Furnace. The first cleaning line cleans the strip prior to its being used on the Coin Roller and can handle strip with a width of 5 inches. The second line handles strip prior to being entered into the cladding line and is capable of handling strip up to 15 inches wide.

Both lines are equipped to remove oxides and foreign materials from the strip surface. The strip is fed into both machines from a coiled form and is recoiled after processing in the machine.

Notes

BLANKING

The blanking is performed on 100-ton blanking presses which operate at speeds up to 250 strokes per minute. These presses can blank strip up to 12 inches wide.

Connected with the blanking press is a scrap chopper which chops the web of the blanked strip into small pieces for ease in handling for use in make-up.

Notes

RIDDLING

The cut blanks from the blanking press are riddled to remove imperfect blanks. The riddler is a vibratory shaker with two horizontal screens. The top screen permits all but the oversize blanks to pass through to the lower screen which allows only the undersize blanks to pass through. All blanks in the acceptable range pass through the shaker between the screens.

Notes

BLANK ANNEALING AND CLEANING

The Mint uses rotary gas fired blank annealing furnaces, each with its own cleaning line. Each furnace is capable of annealing and cleaning 4,000 pounds of blanks per hour.

Notes

UPSETTING

The upsetting of the coin blanks is done on the same rotary upsetting mills we have been using in the old Mint.

Notes

STAMPING

We are presently installing 30 coining presses in the new Mint. Of these presses 18 are standard mint coining presses capable of striking 2-1¢; 2-5¢; 2-10¢; 1-25¢; or 1-50¢ coin per stroke. The remaining 12 presses are a newer design capable of striking 4-1¢; 4-5¢; 4-10¢; 4-25¢; or 2-50¢ coins per stroke. All of these presses run at speeds of 120-150 strokes per minute depending on the individual press.

Several different methods are being employed to feed the presses, e.g., (1) a hopper with a rotating disc feeding the blanks into a tube; (2) a vibrating feeder bowl feeding the blanks into a slide.

Notes

COIN EDGING

After the coin has been embossed in the coin roller it must be edge rolled. The edge rolling operation is similar to the upsetting operation performed on blanks in the conventional method of producing coins.

Notes

INSPECTION

At the present time finished coins are visually inspected on reviewing tables. These tables have slow-moving belts which flip the coin to permit both sides to be reviewed. We are in the process of installing automated reviewing equipment which is explained in another section.

Notes

COUNTING AND BAGGING

The finished coins are placed by overhead crane into the hoppers affixed above the coin counting machine. The coins are then fed by vibratory feeder into the feeder bowl of the first counter. They are counted and then fed into a second counter for verification. The bag is sewed closed with a portable sewing machine and is now ready for storage or shipment.

Notes

There is material on this topic in the back cover-flap of this notebook.

(a) Know Your Money

(b) Secret Service Report to the Public

(c) The United States Secret Service

U.S. Treasury Department
Bureau of the Mint

Notes

U.S. COINAGE DIE OPERATION

Operations in the manufacture of U.S. coinage dies are performed in the following sequence:

1. Approximately 12 foot long annealed tool steel rods are fed automatically into a Conematic machine which cuts the rod into lengths of 2 7/8" and shapes one end into a cone forming a blank.

2. The coned portion of the die blanks are fine ground on a high speed disc grinding machine to remove tool marks made by the Conematic cutting tool.

3. After removal of cutting marks, the cone portion is hand-lapped with a fine abrasive cloth and finally buffed to a highly polished surface.

4. The die blank is centered on the anvils of a hydraulic press and is given its initial hobbing with the working hub. Depending on the denomination, three or four hobbing operations will be required to complete the die impression.

5. Due to the cold working on the die blank, it is necessary to anneal the die blank prior to each hobbing operation. After each annealing, the die blank is cleaned with a dilute solution of hydrochloric acid. Annealing, cleaning and inspection are performed between each hobbing operation.

6. After the final hobbing and annealing operations, the die is machined to the specified configuration.

7. The machined die is then hardened. The dies are packed in individual nichrome cups containing hardwood charcoal. The cups are then placed in a furnace and heated to a temperature of 1475° F and held at this temperature for approximately 2 hours. At the end of the soaking time, the dies are placed face down in a quenching fixture where a water stream is sprayed against each face.

8. The hardened die face is scrubbed with pumice soap and a dilute solution of hydrochloric acid.

9. The dies are heated to 350° F in an atmosphere-controlled furnace and held for $4\frac{1}{2}$ hours, then slowly cooled.

10. The tempered die is tested for hardness on a Rockwell tester, "C" scale.

11. A final inspection is given to each die before it is released for use.

12. The approximate die life per denomination is as follows:

Denomination	Die Life (Strikes)
1¢	850,000
5¢ dual	125,000
10¢	288,000
25¢ single	210,000
25¢ dual	125,000
50¢ single	210,000

13. Die Steel specifications: (Vacuum Melted Tool Steel)

Electric furnace product; 96% to 1.05% carbon; Shepard hardenability 8 to 10 on 3/4" round from 1450° F waterquench; fracture grain size 9 or finer; structure 100% sphereodized; anneal hardness 170 Brinnel maximum; to be supplied fully annealed.

Notes

QUALITY CONTROL IN THE MINTS AND ASSAY OFFICES OF THE UNITED STATES

The primary product of the Bureau of the Mint is coinage. The Mint is also responsible for our gold and silver stocks, maintaining an accurate accounting of their weight and fineness. The Mint also produces certain national medals and other medals approved from time to time by the Congress. One field facility of the Bureau of the Mint performs hundreds of assays yearly on Platinum Group Metals for our Government. In transactions concerning gold, silver and platinum group metals between Government departments and between Government and private contracts, the Mint has always been acceptable as an umpire.

The Assay Offices at New York and San Francisco and the Philadelphia, Pa., and Denver, Colorado Mints receive deposits of gold and silver from the public for exchange in the form of scrap or bars for upgrading, only if the depositor is authorized by the regulations in Part 54 of Chapter 1, Title 31, to receive in return any gold contained therein. Silver deposits will be exchanged if they meet the requisites of Parts 81 and 93 of Chapter 1.

All bullion deposits received at any of the above institutions are mass melted and forwarded to the New York Assay Office at certain intervals for refining.

The assaying of gold and silver submitted for deposit is always kept current. The assays on gold deposits are reported to one quarter thousandth and the silver assays to one half thousandth.

Quality control in our coinage mints in Philadelphia and Denver, and our Assay Office in New York is under the Assayer. These three persons are appointed by the President of the United States, free of encumbrance and are responsible to him through the Director of the Mint. The head of the assay division at the San Francisco Assay Office is accountable for the values of that institution to the Director of the Mint through the Officer in Charge.

The responsibility for quality control on all products, in all institutions, is the Assayer's, whether coinage strip is purchased from private vendors or manufactured in the Mints.

The office of the Assayer at the field institutions selects at least two planchets from each strip during the course of the blanking. These planchets or blanks are checked for thickness, diameter and weight. They are also tested in our "time in seconds" device to determine the electrical resistivity of the coin. This is an all-important factor in quality control as coins unsuitable for vending equipment are unsuitable for circulation. The blanks at each institution are subject to close chemical analysis.

When the "Coinage Act of 1965" became law, the Mint was faced with the need to accurately assay tens of thousands of coin blanks and report the results as rapidly as possible. Wet chemical methods, particularly with respect to the nickel content were far too slow. The Mint installed X-ray fluorescence equipment in the laboratories at Philadelphia, Denver and San Francisco as well as at the Bureau Laboratory in Washington, D. C.

The fluorescence unit is capable of performing qualitative and quantitative analysis. There are two fixed channels, one for copper and one for nickel. Also, there are two scanning monochromators for interchange of wavelengths, one for heavy elements and one for light elements operated in a vacuum.

The Philadelphia Mint fluorescence unit has been equipped with a Digital Voltmeter (DVM) in order to expand the present scale from 0 to 50 millivolts, to 0 to 10,000 millivolts for greater accuracy based on an integration time of 1 minute for each sample.

The assays are performed on samples in the liquid phase and solid phase using the DVM. Coins are weighed, dissolved, and made up to 250 cc. in a graduated flask. The X-ray assay solution is based on a standard prepared by the exact same method. The results of the standard are drawn on a linear curve and each successive sample is plotted against the curve. When the samples are once prepared, the X-ray unit can assay forty samples per hour to an accuracy of one tenth of one per cent.

Assays for the fifty cent coin containing 40% silver are still determined by the Gay-Lussac method, quite common to Mints throughout the world.

All assays in the coinage mints are made on blanks. When the coins have been struck, a representative quantity of each production lot is forwarded to the Bureau Laboratory where the coins are again checked for physical as well as chemical standard. Much attention is paid to the quality of the strike as well as the chemical assay.

The Director of the Mint can be assured that each field facility is properly performing its function by the independent reports submitted by the Washington laboratory. While the percentage of coins selected for examination and assay by the Washington laboratory is a very small percentage of the coinage made, it is taken at random and is representative.

The Bureau Laboratory operates an Electron Microprobe used principally in the detection of counterfeit coinage. This instrument is capable of analyzing an area from 0.5 microns up to 50 microns. The higher limit is rarely used. Its use is for the detection of foreign metal inclusions in a specimen. With this instrument one is able to take backscattered electron photographs and X-ray intensity area photographs of the area under analysis. These photographs show the topography of the area and the dispersion of the particular element in the specimen under analysis.

The new Mint at Philadelphia will be operating four induction furnaces to produce castings. Casting is semi-continuous and each ingot after cropping will be approximately 6600#. After sawing into two halves of 3300# each, these slabs when preheated are ready for hot rolling. When melting of alloys of copper-zinc, cupro-nickel and pure copper are complete and just prior to casting, a billet 1" diameter x 3" long is cast at the furnace and forwarded immediately to the laboratory. Within ten minutes maximum, the billet is cut by a cutoff wheel, sanded on a 400 mesh silicon carbide belt and an assay is made for copper and zinc on the gilding metal, nickel and copper on the cupro-nickel and copper only on pure copper core slabs. Results are phoned to the furnace crew who make any necessary adjustment to the composition of the melt before casting. Phosphor-copper is used in the gilding metal melts and manganese in the cupro-nickel melts as a reducing agent. Assays on these elements, residual in the alloy are not made on every ingot, but are run on a regular basis.

Philadelphia is now operating a metallographic laboratory which will be under the direct control of the Superintendent of the Melting and Refining Division. Necessary samples for the control of grain structure in our strip will be determined directly by them.

Notes

Handbook on Coin Manufacturing Processes at the Mint